Kokee Park Geophysical Observatory

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Abstract

This report summarizes the technical parameters of the VLBI system at the Kokee Park Geophysical Observatory and provides an overview of the activities that occurred in 2012.

1. Location

The Kokee Park Geophysical Observatory (KPGO) is located in Kokee State Park on the island of Kauai in Hawaii at an elevation of 1,100 meters near the Waimea Canyon, often referred to as the Grand Canyon of the Pacific. KPGO is located on the map at longitude 159.665° W and latitude 22.126° N.

2. Technical Parameters

The receiver is of NRAO (Green Bank) design (dual polarization feed using cooled 15 K HEMT amplifiers). The antenna is of the same design and manufacture as those used at Green Bank and Ny-Ålesund. A Mark 5B+ recorder is currently used for all data recording.

Timing and frequency is provided by a Sigma Tau Maser with a NASA NR Maser providing backup. Monitoring of the station frequency standard performance is provided by a CNS (GPS) Receiver/Computer system. The Sigma Tau performance is also monitored via the IGS Network.

3. Staff

The staff at Kokee Park consists of six full time people employed by ITT Exelis under the SCNS contract to NASA for the operation and maintenance of the observatory. Chris Coughlin, Lawrence Chang, Kiah Imai, and Ron Curtis conduct VLBI operations and maintenance. Ben Domingo is responsible for antenna maintenance, with Amorita Apilado providing administrative, logistical, and numerous other support functions. Kelly Kim also supports VLBI operations and maintenance during 24-hour experiments and as backup support.

4. Mission Support

Kokee Park has participated in many VLBI experiments including IVS R4 and R1. KPGO also participates in the RDV experiments. KPGO averaged two experiments of 24 hour duration each week, with daily Intensive experiments in 2012. After the earthquake in Japan in March 2011, KPGO began supporting the INT2 weekend Intensive experiments while data from the Tsukuba VLBI station was being analyzed for weekend Intensive experiment support. The KPGO support of the weekend Intensive experiments concluded in April 2012.

Kokee Park also hosts other systems, including a 7-m PEACESAT command and receive antenna, a Doppler Orbitography and Radiopositioning Integrated by Satellite (DORIS) beacon and remote control, a Quasi-Zenith Satellite System (QZSS) monitoring station, a Two-Way Satellite Time and Frequency Transfer (TWSTFT) relay station, and a Turbo-Rogue GPS receiver. Kokee

Park is an IGS station.

Table 1. Technical parameters of the radio telescope at KPGO.

Parameter	Kokee Park
owner and operating agency	USNO-NASA
year of construction	1993
radio telescope system	Az-El
receiving feed	primary focus
diameter of main reflector d	$20m$
focal length f	$8.58m$
f/d	0.43
surface contour of reflector	$0.020 inches rms$
azimuth range	$0 \dots 540°$
azimuth velocity	$2°/s$
azimuth acceleration	$1°/s^2$
elevation range	$0 \dots 90°$
elevation velocity	$2°/s$
elevation acceleration	$1°/s^2$
X-band (reference $\nu = 8.4GHz, \lambda = 0.0357m$)	$8.1 - 8.9\,GHz$
T_{sys}	$40\,K$
$S_{SEFD}(CASA)$	$900\,Jy$
G/T	$45.05\,dB/K$
η	0.406
S-band (reference $\nu = 2.3GHz, \lambda = 0.1304m$)	$2.2 - 2.4GHz$
T_{sys}	$40\,K$
$S_{SEFD}(CASA)$	$665\,Jy$
G/T	$35.15\,dB/K$
η	0.539
VLBI terminal type	VLBA/VLBA4-Mark 5
Field System version	9.11.1

5. Recent Activities

In January 2012, ITT Exelis support personnel from the Goddard Space Flight Center made a trip to KPGO and, working with local KPGO staff, were successful in repairing the failed NASA NR-1 Maser. The NASA NR-1 Maser remains in its backup role to the Sigma Tau Maser for timing and frequency at KPGO.

The PEACESAT mission came to an end near the end of 2011. In March 2012, KPGO staff and NOAA personnel performed the de-orbit maneuvers of the GOES-7 spacecraft to formally end the PEACESAT support at KPGO.

The KPGO 20-m antenna has been in service for 20 years and is starting to show signs of its age and obsolescence. In March 2012, the KPGO 20-m antenna construction contractor, GD Satcom, made a site visit to assess some observed anomalies in the 20 m's mechanical operation. There is noticeable axial play in the 20 m's azimuth bearing, and it is outside of design specifications but still capable of supporting the VLBI mission. The most significant impact of the axial play is increased wear on the azimuth bull gear teeth caused by the azimuth drive pinions as a result of the degraded tooth mesh with the axial play of the bearing. The GD Satcom engineers indicated that the wear on the azimuth bull gear teeth will eventually result in the 20-m antenna falling out of mission support capability. Actions are being planned to extend the 20 m mission support life-cycle given the current degraded condition of the azimuth bearing and its impacts.

On June 18, 2012, we started our scheduled experiments while our receiver was in the process of re-cooling. As the receiver re-cooled, we noticed that the X-band was not present in our local monitoring systems. We verified the missing X-band with the USNO correlator and began troubleshooting. We reached out to NRAO and NVI for their insights and quickly narrowed the issue down to a failed LNA in the dewar of the receiver. The normal process would be to pull the receiver box and work on removing the dewar with the receiver box in the workshop. With the current rusted state of the receiver box focus rails, bringing the receiver box to the ground and then having to re-focus after re-installation presented substantially increased complexity to the repair efforts. After assessing the side panel access to the receiver box, we were able to partially disassemble some components from the dewar and carefully remove the dewar itself to examine it on an operations building workbench. The practice in previous years was to send the dewar back to NRAO for servicing, which probably would have resulted in an extended period of downtime. After discussing the process with NRAO, we felt comfortable in working on the dewar ourselves. We opened the dewar and verified a failed XR LNA with a short to ground on Stage 1. NRAO had an identical custom built spare on their shelf that they shipped overnight to us to replace the failed LNA. While waiting for the arrival of the replacement LNA, we used our time to clean other components in the cryogenic system and replace worn components as necessary in preparation for re-installation in the receiver box. Some of this work was previously planned including the running of a new 30A circuit up to the helium compressor on the elevation platform, replacing old transducers, replacing a damaged refrigerator, and replacing an aging vac-ion pump. We received the replacement LNA late on June 26 and began work on the dewar first thing in the morning on June 27. We installed the replacement LNA in the dewar and it tested nominal. We worked through some Kokee weather issues and completed the dewar reinstallation into the receiver box and verified nominal status for all components. We re-cooled the receiver into nominal 15K and 50K stage ranges and reached temperature levels we had never previously seen. We discussed this with NRAO and NVI, and we came to the conclusion that we fixed what might have been a bad thermistor connection when we installed the replacement LNA. The readings we are seeing now are very good and nominal. On the morning of June 28 we verified the new LNA readings after it had been cooled for 24 hours, and all were in nominal ranges. We started observing session R4539 at scan 180-2202 upon our return to operational status. After session I12181, we adjusted the bias on the XR LNA per NRAO direction to optimize the X-band performance. The extended team effort by KPGO staff, NRAO, NVI, and remote ITT Exelis support personnel made it possible to identify the problem and get the issue resolved in a little over a week.

The e-transfer of the INT1 sessions from KPGO to USNO were performed over microwave infrastructure provided by the Pacific Missile Range Facility (PMRF) and connecting KPGO to

DREN. Plans to migrate to a dedicated fiber connection to DREN at PMRF have been delayed due to damage to the fibers by a wild fire. MIT is working with the Hawaii Intranet Consortium (HIC) and DREN to improve the KPGO e-transfer rate. Long term plans are still to make real-time VLBI data transfers from KPGO a reality.

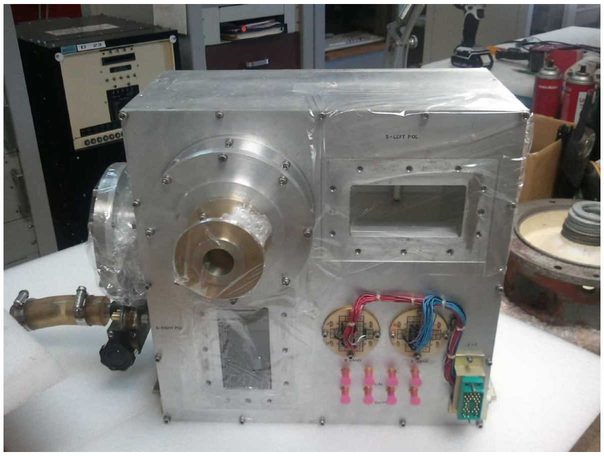

Figure 1. 20-m S/X dewar.

Figure 2. LNA repair.

6. Outlook

GD Satcom is scheduled to make a site visit to KPGO to implement some changes to the KPGO 20-m antenna configuration in an effort to reduce the wear on the azimuth bull gear teeth due to the axial play in the azimuth bearing. Those changes include re-alignment of the azimuth drives to improve teeth mesh between the azimuth pinions and the bull gear. They will also tune the servo system to decrease the acceleration and deceleration of both the azimuth and elevation drive systems.

KPGO is making progress in efforts to upgrade the 20-m antenna signal path to VLBI2010 specifications. The RDBE and up-down converter components of a new digital backend system have been delivered to KPGO from MIT. There have been some discussions on implementing the digital backend components with the existing 20-m antenna S/X feed, and progress on that is currently limited by Mark 5C recorder capabilities at both KPGO and correlators. KPGO staff, ITT Exelis personnel at GSFC, USNO personnel, and MIT have begun planning the final design and installation of a new broadband front end for the KPGO 20-m antenna.

PMRF is working on repairs to the fiber runs that were damaged by a wild fire. Those repairs are expected to be completed in the first half of 2013, and progress on establishing a dedicated fiber path to HIC/DREN for KPGO e-transfers can continue next year.

In September 2012, USNO personnel made a site visit to KPGO to assess possible locations and local environmental impacts of constructing a next generation VLBI antenna. KPGO will continue to assist USNO in an effort to establish a next generation VLBI telescope at KPGO.